

# ISRCS 2008



## Control System Design & State Awareness

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# Participants

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- |                                |                         |
|--------------------------------|-------------------------|
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| ❖ Humberto Garcia              | ❖ Milos Manic           |
| ❖ Alex Chernoguzov             | ❖ Juan Rodriguez-Andina |
| ❖ Keith Daum                   | ❖ Robert Bean           |
| ❖ Craig Rieger                 | ❖ May Chaffin           |
| ❖ Raghu Rengasamy              | ❖ Jay Lee               |
| ❖ Venkat<br>Venkatasubramanian | ❖ Derek Hesse           |
| ❖ Subbaram Naidu               | ❖ Alison Conner         |
|                                | ❖ Jeffrey Joe           |

# Control System Design

## Topical Area #1 - Risk

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- ❖ Past designs were based on risk of failure due to accidents
- ❖ New designs need to be based on risk of failure due to attacks
- ❖ We need to get a handle on what the real risk is

# Current Research

## Topical Area #1 - Risk

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- ❖ Current research
  - Research is too prescriptive

# Research Needed

## Topical Area #1 - Risk

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- ❖ How do you assess risk on unknown of unknowns
  - SHORT-TERM
- ❖ How do you deal with time varying risks
  - Risk dependency on operating conditions
  - SHORT-TERM
  - SHORT-TERM = direct implementation - 2-5 years to complete
  - LONG-TERM = application to cyber - 5-10 to complete

# Rough Estimate Topical Area #1 - Risk

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- ❖ Right people together to think about risk
- ❖ White paper development

# Control System Design

## Topical Area #2 - Design Solutions

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- ❖ Need research to come up with solutions
- ❖ System level principle design
- ❖ Application, functional level design

# Current Research

## Topical Area #2 - Design Solutions

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- ❖ Hybrid
- ❖ Redundancy
- ❖ Reliability

# Research Needed

## Topical Area #2 - Design Solutions

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- ❖ How to bring redundancy and reliability into resiliency
  - SHORT-TERM
- ❖ Correlation between intrusion detection and control systems
  - LONG-TERM
  - Multi agent control system/autonomy level based on negotiation

# Control System Design

## Topical Area #3 - Design Integrity

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- ❖ How to validate design
- ❖ Need test methodology to validate
- ❖ No current research

# Research Needed

## Topical Area #3 - Design Integrity

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- ❖ How to harvest real data systematically for validation
  - SHORT-TERM
- ❖ Test system through defined protocol
  - LONG-TERM
- ❖ How do you harvest real fault data to get a resilient system
  - Where does it go
  - How is stored
  - Commercial data is hard to get
  - Benchmark
  - SHORT-TERM

# State Awareness

## Topical Area #1 – Data and Information Overload

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- ❖ The issue is converting the raw data
- ❖ Needs to be prioritized
- ❖ Data tells you what is going on; Information is about correlations to actions – How
- ❖ Information needed is “Why?”
- ❖ Relies on experience of operator

# Current Research

## Topical Area #1 - Data and Information Overload

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- ❖ Visualization
- ❖ Data Compression
- ❖ Data Mining
- ❖ Feature Extraction
- ❖ Data Modeling
- ❖ Observer Theory
- ❖ Data Fusion

# Research Needed

## Topical Area #1 - Data and Information Overload

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- ❖ How to go from data to decision and back (bi-direction) and how to determine critical data
  - SHORT-TERM and LONG-TERM
- ❖ How to bring global assessment into local assessment
  - LONG-TERM
- ❖ How to deal with non-linear
  - LONG-TERM
- ❖ What's normal for process with what's normal for network to better identify problem
  - SHORT-TERM Cyber issue

# Research Needed (continued)

## Topical Area #1 - Data and Information Overload

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- ❖ Integrated state of awareness
  - Process
  - Infrastructure
  - Human
  - LONG-TERM
- ❖ How do we capture human intelligence in the resilience
  - LONG-TERM
- ❖ Building training with control system and into design
  - LONG-TERM

# Research Needed (continued)

## Topical Area #1 - Data and Information Overload

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- ❖ Balance human and system
  - Level of autonomy
  - LONG-TERM
- ❖ Want to go to hybrids; data and mechanistic integrated approaches
  - LONG-TERM

# State Awareness

## Topical Area #2 – Learn from Biological Systems

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- ❖ Collect data, prioritize, and present it

## Current Research

### Topical Area #2 – Learn from Biological Systems

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- ❖ Neurological control systems
- ❖ Visual perception

# Research Needed

## Topical Area #2 – Learn from Biological Systems

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- ❖ Understand human process of how to process data
  - How to add more complexity into HMIs and bring someone else up to speed
  - LONG-TERM
- ❖ Take advantage of Emergent Behavior
  - LONG-TERM
- ❖ What is the process of learning
  - A way of automating learning
  - LONG-TERM

# State Awareness

## Topical Area #3 – Distributed and Network Systems

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- ❖ Preserve plant production; operate continuously

# Research Needed

## Topical Area #3 – Distributed and Network Systems

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- ❖ How do we use current emergent behavior in resilient design
  - LONG-TERM
- ❖ Theory of rational behavior
  - LONG-TERM
- ❖ Non-linear sampling theory – LONG-TERM
  - Samples coming in at different times – LONG -TERM
  - Data coming in at different rates – LONG -TERM
  - What to sample – SHORT-TERM
  - Sample rate optimization – SHORT-TERM

## Research Needed (continued)

### Topical Area #3 – Distributed and Network Systems

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- ❖ Local control vs. global control – LONG-TERM
  - Bottom up – SHORT-TERM
- ❖ Need local objectives to optimize overall objectives
  - LONG-TERM
- ❖ On-line sensor calibration
  - SHORT-TERM
- ❖ Summarize in graded approach (in context)
  - SHORT-TERM